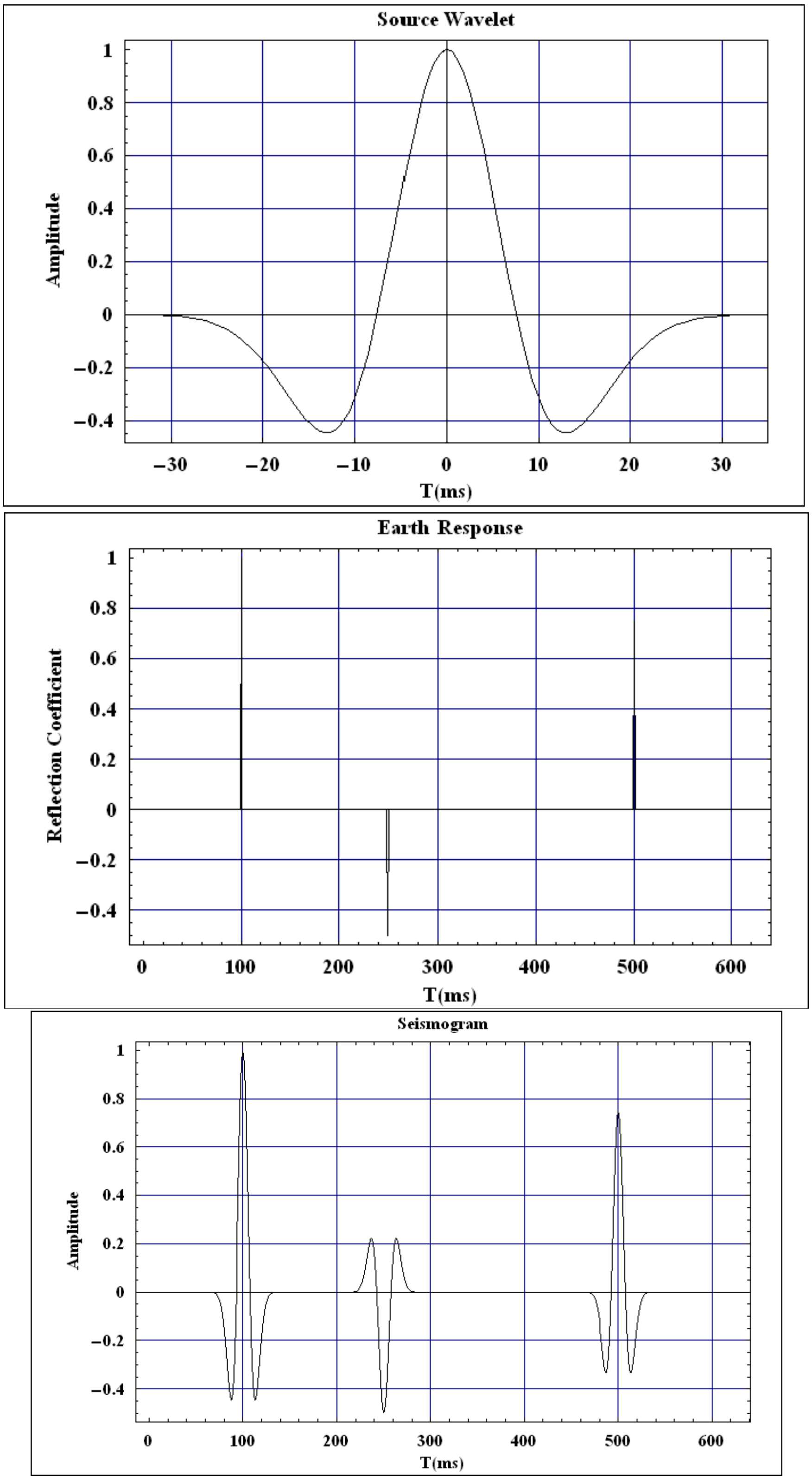
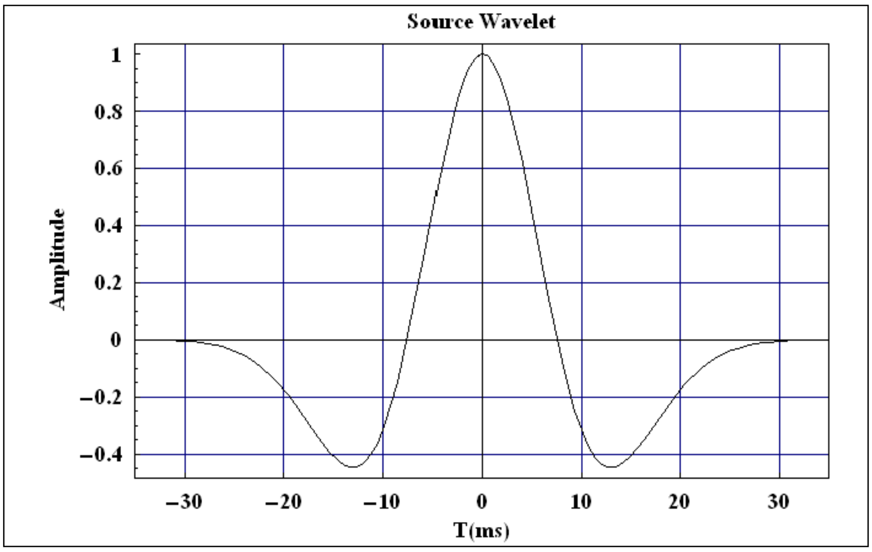
Chapter 3 Figures

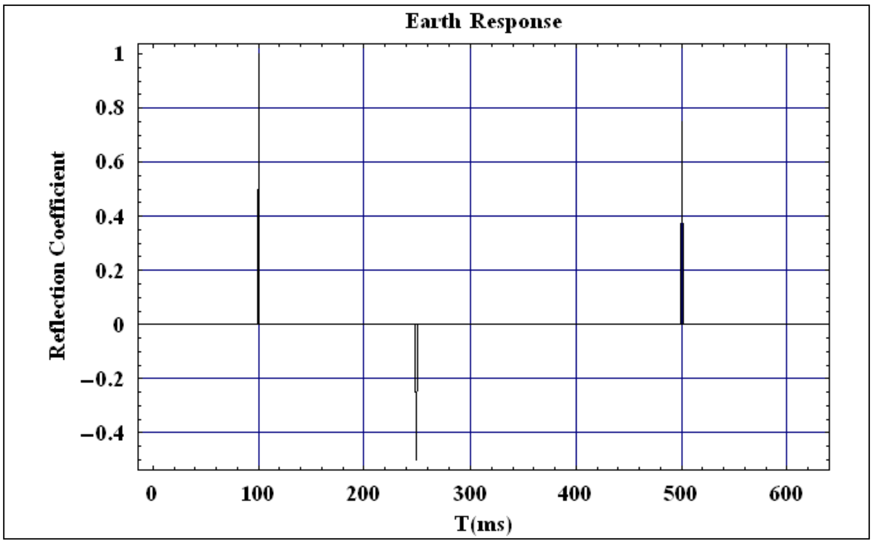
Figure 3.1

Noise-free



Noise-contaminated (sd = 0.1)





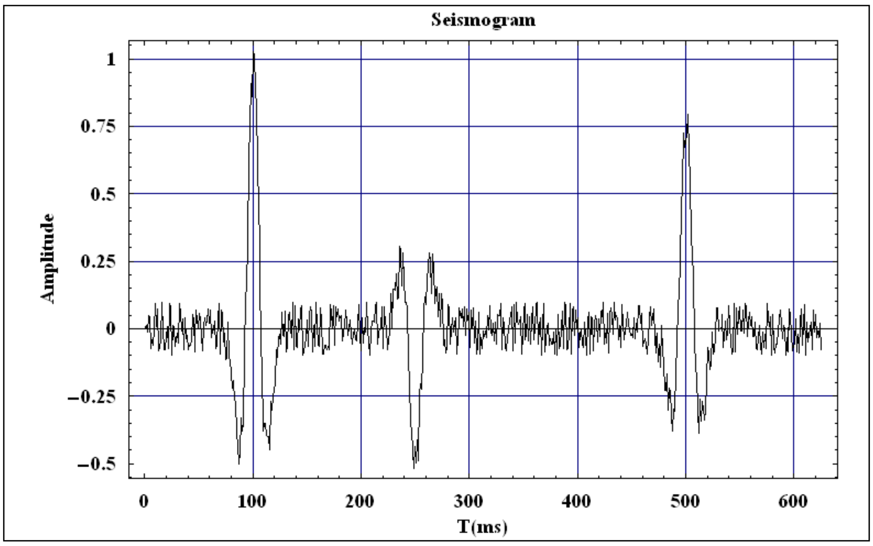


Figure 3.2

Questions

Given the following wavelets:

(a) $w(t) = (2, -1)$

(b) $w(t) = (1, -1)$

(c) $w(t) = (1, -2)$

(1) Find the inverse filters $f_3(t) = (f_0, f_1, f_3)$ of wavelets (a), (b), and (c).

(2) Compute the actual output y(t) of wavelets (a), (b), and (c).

(3) Compute the error E between the desired and actual outputs of wavelets (a), (b), and (c).

(4) Which wavelet has the minimum error? Why?

Answers

(1) Inverse filters:

(a) $W(z) = 2–z; F(z) = 1/W(z) = 1/(2–z) = (1/2)[1/(1-(1/2)z] =$

$(1/2)[1+(1/2)z+(1/4)z^2+...] = 1/2+(1/4)z+(1/8)z2+...; f_3(t) = (1/2, ¼, 1/8);$

(b) Prove that $f_3(t) = (1, 1, 1)$.

(c) Prove that $f_3(t) = (1, 2, 4)$

(2) Actual outputs:

(a) $y(t) = w(t)*f_3(t) = (1, 0, 0, -1/8)$.

(b) Prove that $y(t) = (1, 0, 0, -1)$.

(c) Prove that $y(t) = (1, 0, 0, -8)$.

(3) Errors: $d(t) = \delta(t) = (1,0,0,0)$:

(a) $E = (1-1)^2 + (0-0)^2 + (0-0)^2 + (0+1/8)^2 = 1/64 = 0.015625$.

(b) Prove that $E = 1$.

(c) Prove that $E = 64$.

(4) Wavelet (a) has the minimum error because it is a minimum-phase wavelet while wavelet (b) is mixed-phase and (c) is a maximum-phase wavelet.

Figure 3.3

Let the input be $x(t)=(x0,x1)$ … known

And the desired output be $d(t)=(d0,d1,d2)$ ….. known

And the filter be $f(t)=(f0,f1)$ …….. unknown

Therefore, the actual output will be $y(t)=f(t)*x(t)=(x0.f0,x0.f1+x1.f0,x1.f1)$ …. unknown

The error between the desired and actual outputs is E given as:

$E=(d0-y0)^2+(d1-y1)^2+(d2-y2)^2=(d0-x0.f0)^2+(d1-x0.f1-x1.f0)^2+(d2-x1.f1)^2$

To minimize E w.r.t. f0, we do the following:

$\partial E/\partial f0=0$

$\Rightarrow -2x0(d0-x0.f0)-2x1(d1-x0.f1-x1.f0)=0$

$\Rightarrow (x0^2+x1^2)f0+x0.x1.f1=x0.d0+x1.d1$

$\Rightarrow r0.f0+r1.f1=g0,$ (1)

where: $r(t)=x(t)\otimes x(t)$ and $g(t)=d(t)\otimes x(t)$

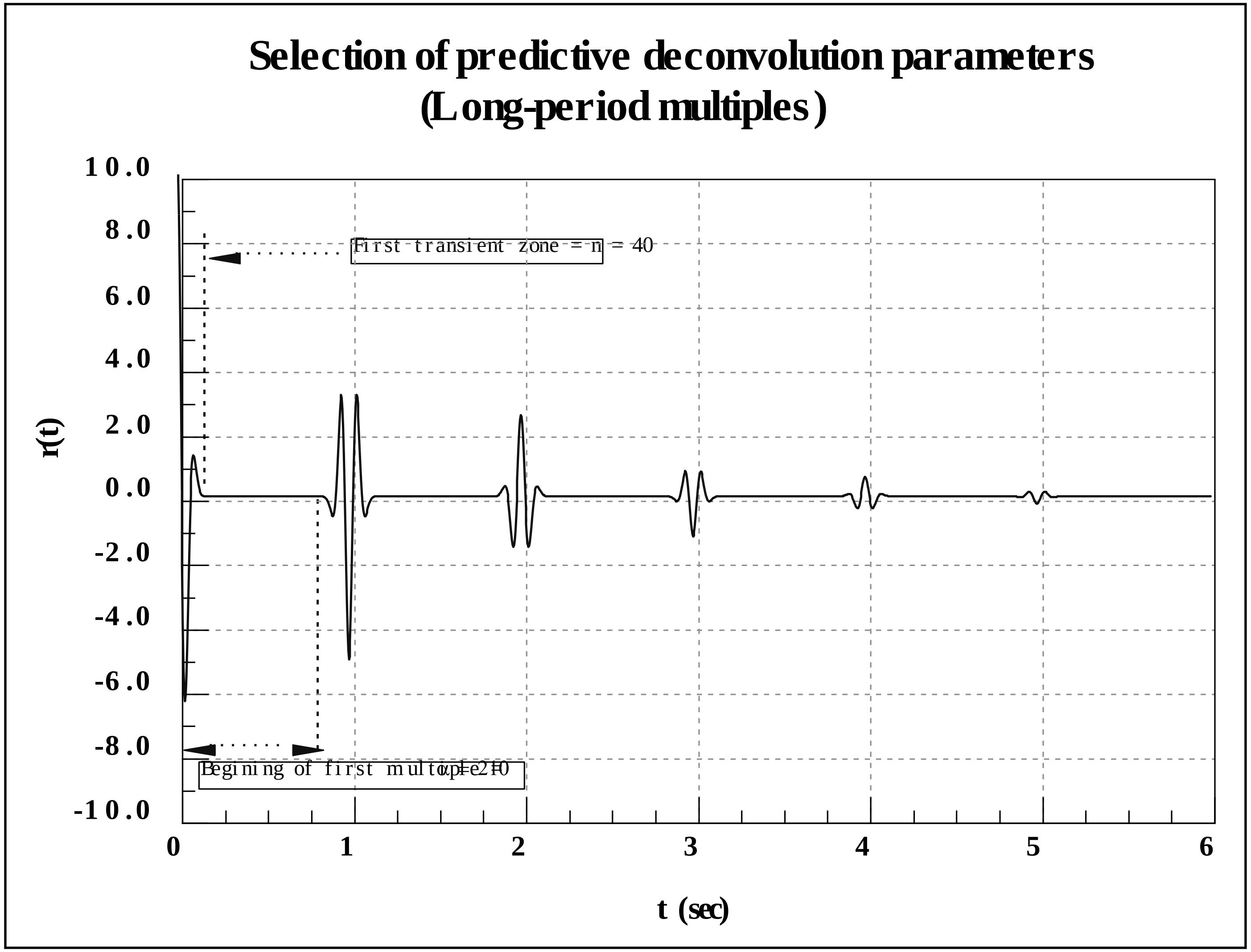
To minimize E w.r.t. f1, we follow a similar approach and get:

$r1.f0+r0.f1=g1,$ (2)

Solving equations (1) and (2) simultaneously, we get the unknown filter coefficients f0 and f1.

Equations (1) and (2) are called the normal equations.

Figure 3.4A



Selection of predictive deconvolution parameters
(Long-period multiples)
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
r(t)
First transient zone = n = 40
Begining of first multiple α = 210
0
1
2
3
4
5
6
t (sec)

Figure 3.4B

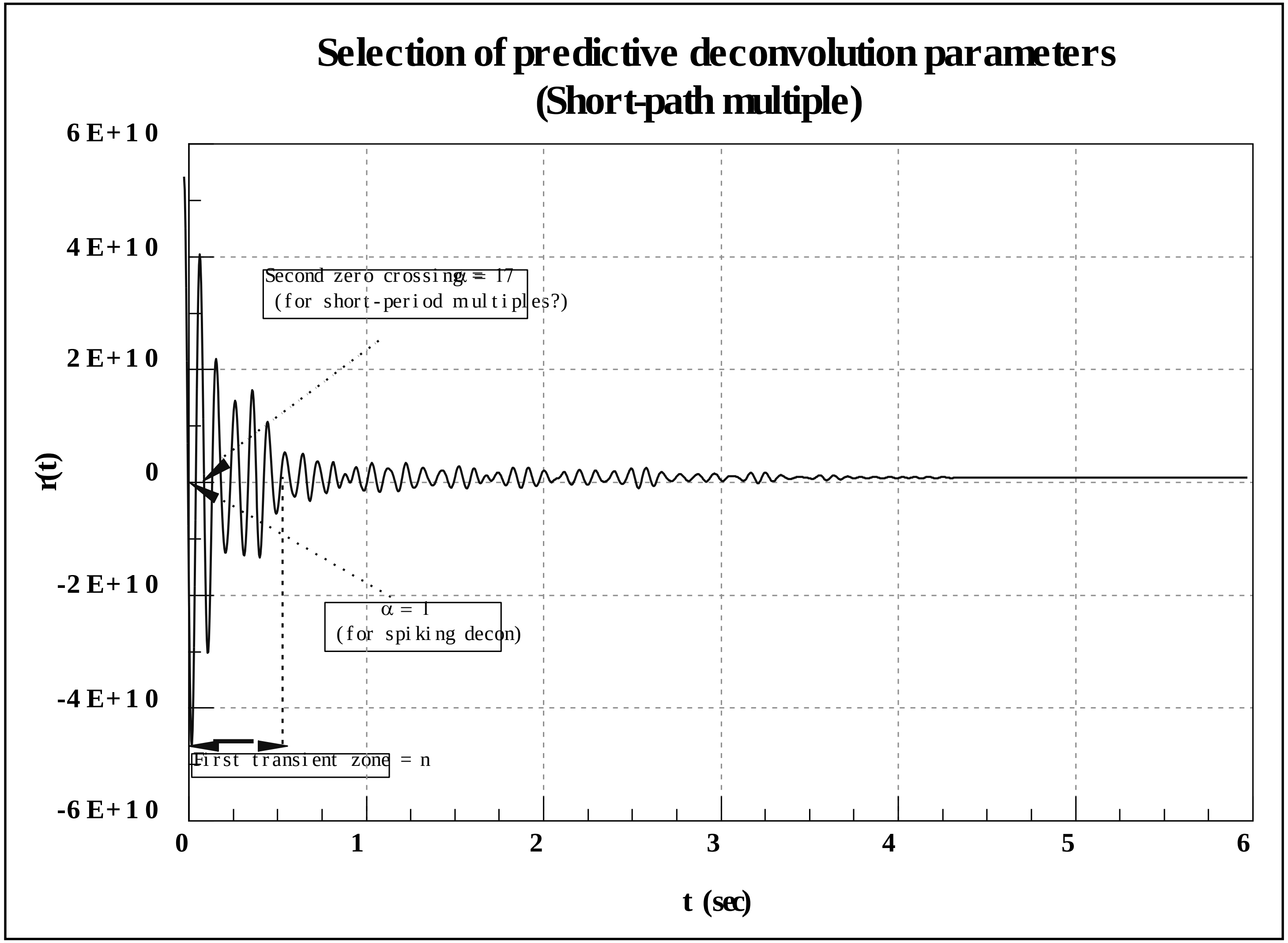
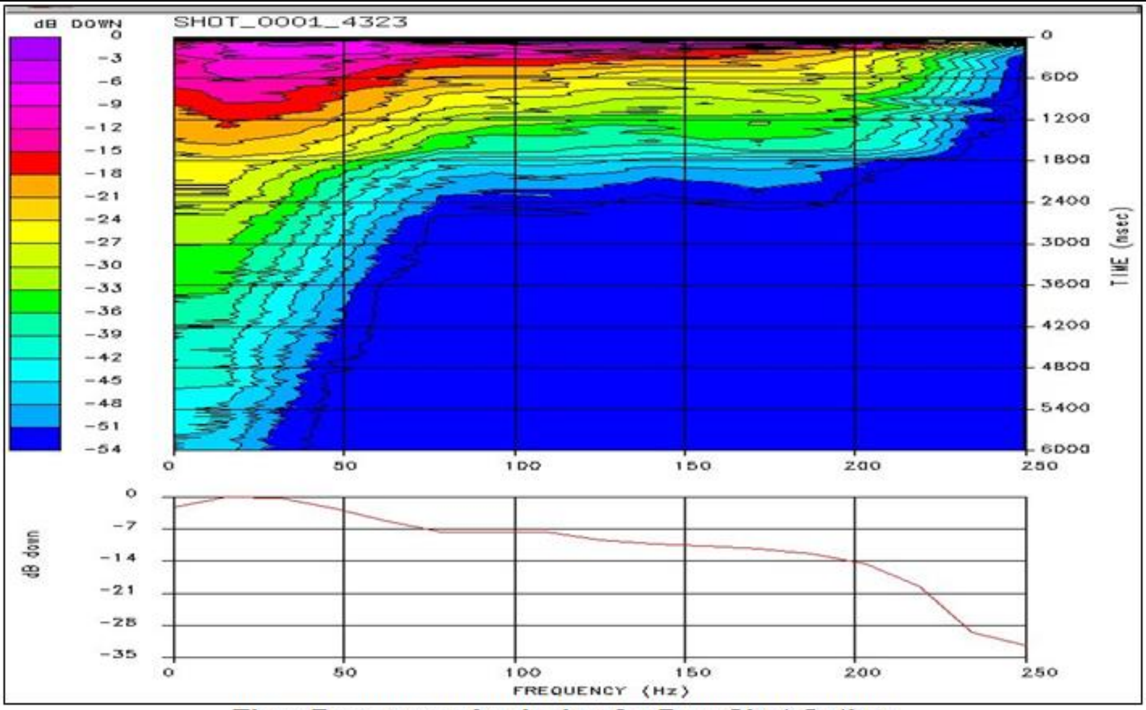

Selection of predictive deconvolution parameters
(Short-path multiple)
6 E+10
4 E+10
2 E+10
0
-2 E+10
-4 E+10
-6 E+10
r(t)
Second zero crossing: α = 17
(for short-period multiples?)
α = 1
(for spiking decon)
First transient zone = n
0
1
2
3
4
5
6
t (sec)

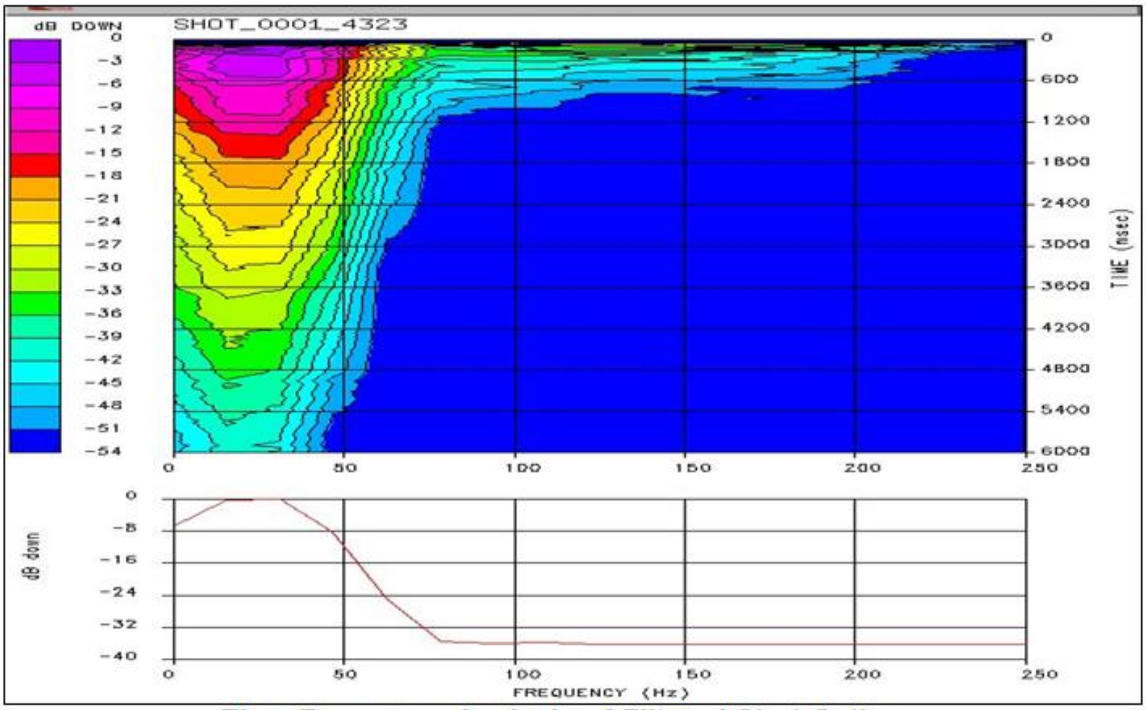
Figure 3.5

Parameter	Spiking deconvolution	Multiple suppression	
		Short-period (e.g., ghost)	Long-period (e.g., water-bottom)
Autocorrelation Window (w)	➢ As long as possible. ➢ Should be in a section with the highest S/N ratio. ➢ Should be greater than eight times the longest operator length = $8n_{max}$.		
Operator length (n)	➢ As long as possible. ➢ Should include the first transient zone.		
Prediction lag (α)	1	Second zero crossing	Beginning of first multiple
Prewhitening (ε) (%)	0.1		

Figure 3.6



Time-Frequency Analysis of a Raw Shot Gather



Time-Frequency Analysis of Filtered Shot Gather

Figure 3.7

- G: Airgun (source), H: Hydrophone (receiver), sampling interval = Δt, and $c = T_0/\Delta t$.
- $dT << T_0$ is selected optimally such that the upgoing and downgoing waves add up in phase and a magnified downgoing wave is always recorded by the receivers.